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**Fat Taxes and Health Outcomes: An Investigation of Economic Factors
Influencing Obesity in Canada**

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Tax policy has been proposed as a possible instrument for reducing the incidence of obesity and diet-related non-communicable diseases. This has become popularly known as the "fat tax" approach. Also, physical access to energy-dense, nutrition-poor food items has been suggested as a causal factor for rising obesity rates. This project investigates both the role that food price interventions and physical access to "fast food" may play in population levels of obesity.

Keywords: Obesity, Health Policy, Fat Taxes, Fast Food, Food Access, Built Environment

JEL Classification: I18, Q18

Introduction

A perceived epidemic of obesity in most of the developed world, and increasing incidence of obesity in poorer countries, has ushered in a new era of concern for dietary health. In recent years there has been an international debate on what, if anything, governments should do to decrease both the social and private costs associated with overconsumption and poor food choices. Many commentators have suggested that fiscal interventions should be a key tool in the arsenal that policymakers use to attack the problems of obesity and dietary-related disease. Much of this discussion has focused on the “fat tax” approach, which seeks to discourage consumption of unhealthy foods by increasing the effective price to consumers. Subsidies designed to make healthier foods more accessible to consumers have also been proposed. In the first part of this report, we review the economic evidence on food price interventions, and raise both pragmatic and conceptual concerns with the use of such policies to intervene in public health issues.

In the second part of this report, we investigate the relationship between the incidence of fast food outlets and the prevalence of obesity across Canadian cities. Evidence from the 2004 Canadian Community Health Survey indicates that there are considerable regional differences in obesity across Canada (Shields and Tjepkema, 2006). We use data on the location of fast food establishments from the 2005 Business Locations database (compiled by Environics Analytics) to construct various indices representing the accessibility of fast food across Canadian metropolitan areas, and investigate whether these indices can help explain the variation in obesity rates. The accessibility of fast food varies greatly across Canadian metropolitan areas. These measures, when compared to obesity rates across cities, yield insights into how fast food access may impact dietary health. The “top ten” fast food population density measure is notably correlated with the incidence of obesity (Pearson’s $r = 0.52$) and overweight and obesity combined ($r = 0.44$). This evidence suggests that the incidence of obesity and overweight is related to the accessibility of fast food in Canada, however, causal directions in this relationship are ambiguous.

The Economic Evidence on Fat Taxes

The material in this section is forthcoming as an invited paper by Sean B. Cash and Ryan Lacanilao in the *Agricultural and Resource Economics Review* (October 2007).

A perceived epidemic of obesity in most of the developed world, and increasing incidence of obesity in poorer countries, has ushered in a new era of concern for dietary health. In recent years there has been an international debate on what, if anything, governments should do to decrease both the social and private costs associated with overconsumption and poor food choices. Many commentators have suggested that fiscal interventions should be a key tool in the arsenal that policymakers use to attack the problems of obesity and dietary-related disease. The most familiar of these policies is the “fat tax” approach, which targets either individual food items or macronutrient content across food items. The most commonly discussed form of fat tax is a levy on high calorie or high fat food, designed to achieve reductions in the incidence of obesity and chronic diseases (Schmidhuber, 2004). Some researchers have argued that a tax need not change consumption significantly to improve public health outcomes, as such taxes can effectively generate revenue to fund health promotion programs (e.g., Jacobson and Brownell, 2000). Subsidies designed to make healthier foods more accessible to consumers have also been proposed.

Much of this debate has proceeded with minimal input from economists, although recent work in the published and “grey” literature has begun to provide evidence to inform this discussion. This paper briefly reviews some of that literature, and highlights some of the theoretical and pragmatic issues around such interventions. We do not claim to be particularly comprehensive or objective in our treatment of this issue, but rather intend only to draw attention to some of the relevant work and considerations that should be brought to bear on this topic.

Is There a Role for Government?

According to a recent World Health Organization (WHO) report on prevention of non-communicable diseases, consumers should limit energy intake from fat and shift consumption from saturated and trans-fatty acids; increase consumption of fruits, vegetables, legumes, whole grains, and nuts; limit the consumption of free sugars; limit

salt intake; achieve energy balance for weight control; and engage in adequate levels of physical activity throughout life (World Health Organization, 2003). Let us assume for now that society accepts these goals as desirable, and furthermore that consumers are unlikely to achieve them if left to their own devices. Before decision makers try to turn these dietary goals into policy goals, we should still ask two key questions: Can government effectively force healthy diets on consumers, and even if so, should it?

Economists usually answer the latter question by arguing that government intervention into the public realm is justified in the presence of market failures (and only if the cost of the intervention is outweighed by the benefits). Such failures include imperfect market competition, high external costs or benefits to third parties, imperfect information, and the provision of public goods. All of these failures may be evident to some extent in the market for health and wellness. In regards to food policy and health, the most salient failure is probably the lack of full information, especially on the part of consumers. In the absence of standardized labeling requirements in most countries, consumers would generally be unaware of the nutritional characteristics of the food they eat. Even if consumers read the contents of the labels that their governments have insisted be made available to them, they are not necessarily aware of the implications of consuming that item for their health. Given that for many products and nutrients there is little consensus even within the scientific community, and that the information that does reach consumers is often fragmented or even conflicting, this is hardly surprising.

The high societal costs of diseases related to food consumption, particularly publicly financed health care costs, are also frequently cited as a reason for government involvement. The total annual direct costs of obesity in Canada were estimated by Katzmarzyk and Janssen (2004) to be \$1.6 billion in 2001 Canadian dollars; other estimates are higher but similar. In the United States, annual medical costs attributable to obesity and overweight in 1998 may have been as high as \$92.6 billion in 2002 dollars, approximately half of which were paid by Medicare and Medicaid (Finkelstein, Fiebelkorn, and Wang, 2003). Intervention is further justified by indirect costs faced by third parties, such as those incurred by employers through lost productivity or increased insurance premiums.

Additional theoretical insight into this line of argument can be gained by borrowing a few key concepts from environmental economics, the subfield of economics that most frequently confronts questions of externality. One useful idea is the “polluter pays” principle. On its face, taxing the consumer of less desirable foods would seem to be a natural analog to this concept, in that the “polluter” here is the individual who contributes to the public costs of health care by increasing their risk of disease through consumption of a less healthy diet.

What, then, is the appropriate tax? We may accept some damaging behavior, but we should reduce it because the market for food ignores the external health care costs associated with consumption of less healthy foods. Outright bans are only justified when these costs completely outweigh the private benefits of buying and selling “junk” food. The generally accepted rule for achieving an optimal social outcome in the face of negative externality is to tax the damaging activity at a rate equal to the marginal external cost at the optimal level of provision. In practical application to food products, however, the marginal damage of a unit of unhealthy food is very difficult to determine, and may be zero for many consumers, in that even unhealthy food choices may pose negligible risk in the context of an otherwise healthy diet. In other words, the proper Pigovian tax would be on changes to overall dietary composition and not on food items *per se*. As the former is probably impossible to implement, one might reasonably conclude that fat taxes are unlikely to achieve optimal outcomes. The question is then whether or not they can provide a higher level of welfare than the status quo.

Although some observers of a libertarian bent may see the market failure model as being too inclusive, many health professionals would argue it is either too narrow or irrelevant. In medicine, an intervention is something that is introduced to the patient by a caregiver, and interventions are justified by weighing the possibility of improving the health of the patient against the risks of intervening. In this view, as long as the intervention is justified on medical grounds, one could argue it makes little difference whether the agent of change is a family physician or a government program.

There have also been calls to broaden the theoretical justification for food price interventions beyond the traditional market failure model from within economics.

O'Donoghue and Rabin (2006) investigate whether food taxes can create welfare gains when some consumers exhibit self-control problems, which they implicitly define as consumption of a good beyond the point that satisfies the consumer's own intertemporal utility maximization problem. Their model suggests that food price interventions can be not just welfare-enhancing, but can even create Pareto improvements if proceeds are returned to consumers. Empirical support of this view can be drawn from the work of Richards, Patterson, and Tegene (2004), who suggest that carbohydrates, fat, protein, and sodium are rationally addictive goods, in accordance with the theory described by Becker and Murphy (1988).

The Economic Evidence

Fat Taxes

We now briefly turn our attention to the economic evidence addressing the question of whether governments can achieve desirable dietary goals through food price interventions. Some recent studies suggest that fat taxes may be effective in reducing unhealthy food consumption. Schroeter, Lusk, and Tyner (2007) created a microeconomic model to estimate the effects of a tax on high-calorie food. They conducted empirical analysis by obtaining statistics for price and income elasticities and using energy accounting to come up with weight elasticities. One of their findings was that a tax on high calorie soft drinks would cause a decrease in weight through decreased soft drink consumption. Other researchers who have focused their studies on soft drinks have similarly found that a tax on soft drinks may effectively decrease their consumption (Gustavsen, 2005; Tefft, 2006). Tefft (2006) used a reduced form linear approximation to estimate the effect of a tax on soft drinks. He found that a tax on soft drinks may result in decreased snack food consumption and increased revenue due to increased expenditure. It is important to note that he measures expenditures rather than quantities. Richards, Patterson, and Tegene (2004) used household scanner data in a random coefficient (mixed) logit RCL model to test if rational addiction to food nutrients may be a cause of obesity. They found that a rational addiction to carbohydrates, fat, protein and sodium exists and concluded that fat taxes may be more effective than information-based policies. Using a linear approximate almost ideal demand system (LA/AIDS) to simulate

tax effects on intake, Santarossa and Mainland (2003) found that price increases on certain food groups may be an effective way to induce people to substitute harmful nutrients for healthier ones.

Other researchers are not as hopeful. Kuchler, Tegene, and Harris (2004) simulated health outcomes of a fat tax by using reduction in weight as a measure of health. They calculated the effects of a tax on different levels of consumer responsiveness to price. For each elasticity scenario, four possible tax rates ranging from 0.4 to 30 percent were considered. They were able to calculate reduction in caloric intake for each scenario, assuming that nothing was substituted for the salty snacks and that all food purchases are consumed. From this they calculated reduction in body weight (3500 kcal per pound of body weight). Their results show that a small tax of 0.4 or 1 percent would not significantly affect consumption or health outcomes. In later work, the same authors further estimated demand functions for potato chips, all chips and other salty snacks. Using the resulting elasticity estimates, they explored the effects of a 1, 10 and 20 percent tax on each snack category. They found that a small tax on salty snacks would not impact diet very much and even a relative large tax would not appreciably affect the diet quality of the average consumer (Kuchler, Tegene, and Harris, 2005).

Smed, Jensen, and Denver (2005) combined econometric models of food consumption behavior in socio-demographic groups with models for conversion between food consumption and nutrient intake. They conducted simulations of four different scenarios: a tax on all fats, a tax on saturated fats, a tax on added sugar, and a subsidy on fibers. These are taxes on nutrients rather than types of food. They found that a tax on fats would decrease fat intake but increase sugar intake while a tax on sugar would decrease sugar intake but increase fat intake. Although these tax scenarios predict a decrease in energy intake, the authors conclude that tax or subsidy alone could not solve the obesity problem. They suggest combining a tax with other regulations, such as information campaigns, since there might be an interactive effect.

Boizot-Szantai and Etilé (2005) used data from a French food expenditure survey to model the effects of different food group prices, income, and demographics on BMI. Their results suggest that the effectiveness of a fat tax may be limited in the short-run.

Clark and Levedahl (2006) used a generalized addilog demand system (GADS) to estimate a demand-characteristic system for beef, pork and poultry. According to their estimates, a tax that would increase the price of pork would increase the consumption of fat from pork and may contribute to obesity. They suggest that policies to raise income would be more effective at decreasing fat consumption.

The state of Maine had a snack tax between 1991 and 2001. Oaks (2005) used this as a natural experiment to evaluate the effect of a snack tax on obesity outcomes. The design of his project is an interrupted time series comparison group. His analysis revealed no relationship. He argued that although his study fails to support the hypothesis that a snack tax reduces obesity rates, the revenues observed from the snack tax could have been used to support other programs that may be more effective at reducing obesity.

Thin Subsidies

One area of research that has not been fully explored but holds much potential is the analysis of “thin subsidies”. Although such subsidies would require government outlays, this money would be returned to taxpayers in the form of lower food prices. The goal is to promote a better diet by making healthier food options more accessible. In turn, lives would be saved through decreased incidence of diet related diseases, lessening the burden on the health care system. For example, Schroeter, Lusk, and Tyner (2007) analyzed several price change scenarios in their simulation analysis, and found that the most effective scenario to decrease weight was a subsidy on diet soft drinks.

Cash, Sunding, and Zilberman (2005) estimated the health potential of thin subsidies, using epidemiological evidence on the efficacy of fruits and vegetables in reducing heart disease and stroke. They ran simulations using intake and sociodemographic variables from the 1994-96 U.S. Continuing Study of Food Intakes by Individuals. Health outcomes were estimated by using dose-response functions for the protective effects of vegetables and fruits. According to their simulation, a 1% decrease in the price of vegetables and fruit could be associated with almost 10,000 prevented cases of coronary heart disease and ischemic strokes in the United States. They concluded that a thin subsidy could be an effective way to provide health benefits,

especially to disadvantaged consumers. Their estimates of the cost per statistical life saved, shown in Table 1 below, compare favorably with the costs associated with other U.S. government programs.

Table 1. Present value of cost per life saved by avoiding heart disease and stroke through small fruit and vegetable subsidies (Source: Cash, Sunding, and Zilberman, 2005)

Commodity	All incomes	Low income	Medium income	High income
Fruit and vegetables	1.29	1.02	1.19	1.45
Fruit	2.19	1.82	2.17	2.31
Vegetables	1.80	1.33	1.62	2.12

Low income refers to families below 130% of the poverty income guidelines, and high income households are above 300% of this level. All numbers are in millions of 2002 US dollars.

Asfaw (2007) used data from a 2007 household survey conducted in Egypt, which included food expenditure. His model estimation used mother’s BMI as the outcome variable, which he explained as a function of different food prices, controlling for age, male/female headed households, education, family size, urban/rural, monthly expenditure, and distance to nearest bread shop. His results imply that lower prices on healthier foods such as fruit, milk, and eggs are associated with a lower BMI and that lower prices on energy-dense food items such as sugar and oil are associated with a higher BMI. These results suggest a thin subsidy may be an effective way to decrease BMI in a developing country context.

Gelbach, Klick, and Stratmann (2007) analyzed how bodyweight is affected by the price of healthful food relative to unhealthful food. They used individual level data on obesity and demographics from the National Health Interview Survey (NHIS) for the years 1982-1996 and combined them with regional level food price data. They created price indices of healthful and unhealthful foods, and used the ratio of the two as the key regressor. They also controlled for many demographic variables such as education, race, age, and region. Their regressions show a significant, positive relationship between the relative prices of healthful foods and BMI. Furthermore, their analysis suggested that this is a causal relationship. Although the relationship was statistically significant, the coefficients were modest. On balance, this study suggests that a tax on unhealthful foods

or a subsidy on healthful foods would cause a decrease in bodyweight, but not an economically significant one.

In the public health and dietetics literatures, Simone French and colleagues have reported several experimental studies involving environmental interventions (French et al., 1997a; French et al., 1997b; French et al., 2001; Jeffery et al., 1994). French et al. (1997a) set up environmental interventions to determine the effects of pricing strategy on fruit and vegetable purchases in school cafeterias. They made fruit, carrots and salad in each school cafeteria about 50 percent cheaper during the intervention period and advertised these new prices. During the intervention period fruit sales increased by about four fold and carrot sales approximately doubled. Salad sales were not significantly different. With the increased sales from lower prices, sales revenue was not significantly reduced. This study suggests that decreasing the price of fruits and vegetables with minimal promotion may be an effective way to increase sales of these items to high school students (French et al., 1997a). Jeffery et al. (1994) conducted a similar experiment in the cafeteria of a university office building. In addition to reducing the prices of fruits and vegetables they increased the selection. The results suggest that increasing selection and decreasing the price of fruits and vegetables may be an effective way to increase the amount of fruits and vegetables adults purchase (Jeffery et al., 1994).

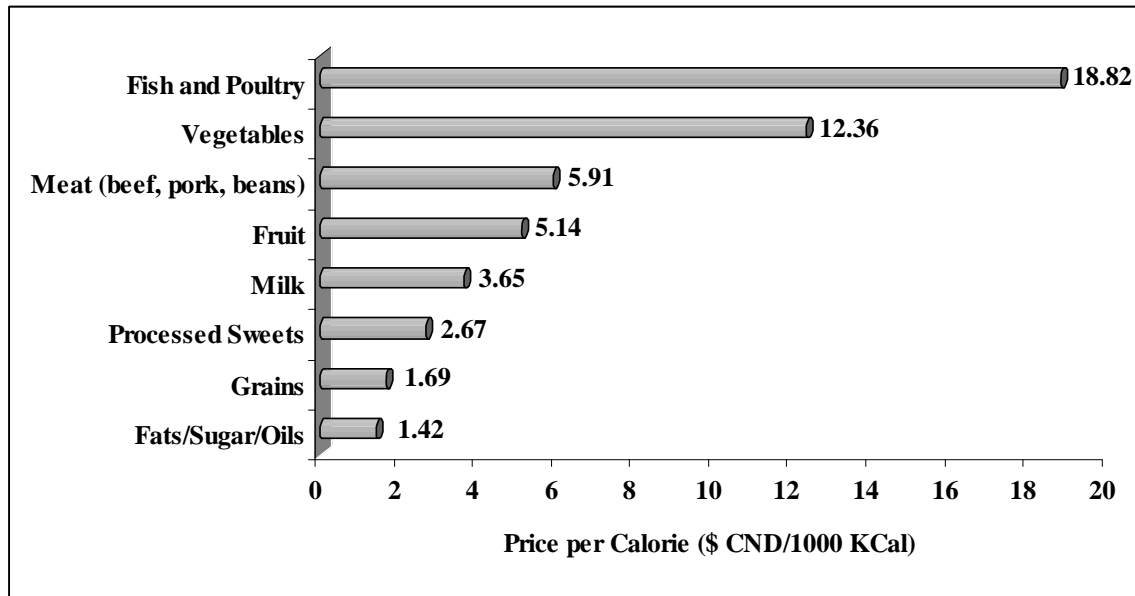
French et al. (2001) used an experimental design to determine the effects of decreasing the price of low-fat snacks relative to regular snacks in vending machines. Four levels of pricing were examined. They found that a 10 percent decrease in price of low-fat snacks increased the percentage of snacks sold that were low fat without increasing sales volume, which suggests that customers may have been substituting low-fat snacks for regular snacks. This is a positive result from a public health perspective. Decreasing the price of low-fat snacks by 25 or 50 percent caused an increase in sales volume, which suggests that consumers may be buying more snacks from the vending machine, which could imply a negative net health outcome. Another possibility is that more consumers were attracted by the price decrease to those particular vending machines used in the study. It is difficult to evaluate the overall efficacy of these interventions because it is not known how the consumers ate throughout the day. An interesting finding of the last study is that lower prices on low-fat snacks were not

associated with smaller profits, suggesting that this may be an inexpensive intervention (French et al., 2001). Environmental interventions in a restaurant setting have yielded similar positive results (Horgen and Brownell, 2002).

Distributional Effects

A common concern is that fat taxes may be regressive. In the simplest form of the argument, it is probably sufficient to note that low-income consumers spend a larger portion of their income on food, so that any policy that broadly raises food prices will have the greatest relative impact on poor households. Food energy price studies, such as the one conducted by Drewnowski and Specter (2004), have indicated that there is a huge gap between the cost per calorie of energy-dense, nutrition-poor (EDNP) food items such as sugar and healthier food items such as vegetables and lean meats. Figure 1 shows the results of a similar study we conducted for 56 food items across a sample of 20 Edmonton supermarkets. In this study, we found a ten-fold difference in the price per energy unit of fish and poultry (\$18.82 CND/1000 KCal) compared to the price of fats, sugars and oils (\$1.42 CND/1000 KCal). Across individual food items, there was approximately a sixty-fold difference in energy cost between turkey slices (\$25.79 CND/1000 KCal) and sugar (\$0.44 CND/1000 KCal) (Cash and Lakanilao, 2007). If one accepts that meeting basic energy needs will come before other nutritional concerns, this vast difference in food energy prices suggests that at least for the lowest-income consumers, there is already considerable price pressure to buy EDNP foods. In this context, raising the prices of precisely those foods that provide food energy at the lowest cost is very likely to be regressive.

Figure 1. Average price per thousand kilocalories for various food groups in Edmonton supermarkets (Cash and Lacanilao, 2007)



This premise was also examined by Leicester and Windmeijer (2004), who used data on dietary intake and household income from the 2000 U.K. National Food Survey to investigate how macronutrient intake varies across the income spectrum. Their analysis suggests that a flat tax targeting fat, sodium, and cholesterol would have an effective tax rate of 0.7% for the poorest consumers, but only 0.25% for those at median income, and as little as 0.1% for the wealthiest households. Another study, investigating a tax on fat content in dairy products, similarly found that such a tax would be regressive in nature (i.e., the elderly and poor would suffer the greatest welfare losses) (Chouinard et al., 2007).

Other studies have indicated that policies designed to make a healthy diet more affordable may be most effective among those with lower socioeconomic status (Darmon, Ferguson, and Briend, 2002; Cash, Sunding, and Zilberman, 2005). In contrast, Gustavsen and Rickertsen (2004) found that households that consume high amounts of vegetables are more sensitive to vegetable price than low-consuming households, suggesting that a thin subsidy on these products may nonetheless have the greatest benefit to high-income consumers.

Discussion: A Practical Critique of Fat Taxes

The evidence cited above offer conflicting policy prescriptions, in that the estimates of the population health effects of food price interventions vary widely. Even those studies that do suggest health benefits can be achieved through taxation policy often find that modest taxes will produce only modest health benefits. Any consideration of larger price changes should be viewed cautiously. Those studies which attempt to use elasticity estimates to simulate substantial price changes are often committing two inferential sins: applying a marginal measure inappropriately, and predicting values well outside of the observed range of the data.

In addition to the concerns raised in some of the studies cited above, there are many practical considerations that arise when one contemplates the implementation of food price interventions.

The Targeting Problem

The actual implementation of any tax requires very specific criteria. One can not simply instruct retailers and restaurants to tax the less desirable food items that they sell. Specific guidelines must be developed as to what categories of food will be included, and which will not be affected. For example, soft drinks are often touted as a likely candidate for health-based taxation – but the precise definition of a soft drink is not self-evident. Is it a carbonated drink with a certain number of grams of sugar per serving? This would cover cola, but exclude lemonade. If we include non-carbonated beverages, this would also include fruit juices. If we exempt beverages with any fruit juice content, we could prompt consumers to switch to reformulated products that no longer meet the standard for taxation, but are not any more benign for dietary health than the products they favored previously.

Similarly, we must also acknowledge that it is difficult to address population heterogeneity with a point-of-purchase tax. The possible regressiveness of such taxes has been noted above. Furthermore, a certain energy-dense food may be a poor choice for much of the population, but an absolute boon to the health of a long-distance runner the day before a race. The saturated fat content of whole milk may seem a likely candidate for taxation for adults, but parents are advised to give their young children whole milk. It

is obviously impractical to tax a product differently on the basis of who in the household may be consuming it.

The targeting problem points to a critical asymmetry between fat taxes and thin subsidies. When a healthier food choice is subsidized, it is relatively easy to predict an increase in the consumption of the targeted food. In contrast, when an individual food item is differentially taxed, the potential universe of substitutes is quite large. While economists may be reasonably capable of predicting substitutions across broad categories of food, or within narrow categories, our ability to predict and track substitutions across tens of thousands of products is hampered both by methodology and data availability. While a high tax on saturated fat content may seem like a definable task, the reality is that people choose food items, not macronutrients. We can say very little on how diets will change under a regime of broadly imposed tax increases. Ineffective and even perverse outcomes of such programs are not just theoretical possibilities.

Producer Responses

Levying taxes requires authorities to draw “bright lines” around the products that will be taxed, which allows producers to reformulate the product to avoid the tax. If regulators choose to tax only the most egregious products, producers will step just over the line, with perhaps negligible improvement in health outcomes. If regulators instead choose to cast a wider net to guarantee that product reformulations do not easily render the taxes moot, many relatively benign products will also be affected. In the latter case, the policy will impose considerable costs that do not directly lead to improved health outcomes.

It is also important to note that some food ingredients that may be targeted are produced in tandem with others that would not be directly subject to the proposed taxation schemes. For example, taxing the consumption of saturated fat content in dairy will not change the fact that a certain amount of milk fat is present in unprocessed cow’s milk. Producers will not destroy commodities or by-products that can be sold elsewhere. If producers are not able to sell these products easily in domestic markets, they will export it, thus increasing the availability of these products elsewhere. Alternatively, these products will find their way to domestic consumers through another avenue in food

processing, and still may be consumed by the public – either in food items that have been exempted from the tax, or in items that exhibit lower own-price elasticities.

A useful illustration of how policy changes can prompt this sort of reformulation is provided by Cash, Wang and Goddard (2005). In the years after 1% fluid milk was first made available in 1990 to consumers in Canada's tightly regulated dairy markets, it quickly gained market share from both whole and 2% milk, reaching a consumption level of 20 liters per capita per year by 2003. During the same time period, sales of butter went down, but sales of total cream and variety cheeses increased substantially. It would appear that Canadian consumers dutifully drank less milk fat once they had the option to purchase 1% milk, and proceeded to eat it some of it instead – with the largest increase appearing in relatively expensive variety cheese products.

Existing Price Distortions

It is also important to note that food prices in much of the world are already affected heavily by existing taxes, trade restrictions, transportation policy, energy taxes, food assistance programs, environmental policies, and other interventions. Several observers have noted that agricultural policies in the United States, Canada, and Europe influence food prices in ways that are often incompatible with public health goals (Alston, Sumner, and Vosti, 2006; Cash, Goddard, and Lerohl, 2006; Lobstein, 1998). If improving health is the priority, it would seem reasonable that removing the barriers to healthy diets posed by such policies should take precedence over the introduction of new taxes. If health concerns are not pre-eminent over all other social goals, then it must be noted that fat taxes may have undesirable consequences for the outcomes that these other programs are supposed to achieve.

Conclusion

There are several other issues around the implementation of fat taxes beyond the ones discussed above. The political feasibility of any such program is unclear, particularly if large price changes are suggested. The evaluation of every existing and new food product for macronutrient-based taxation schemes is a huge administrative task that would likely take years to implement. Legal challenges from affected producers, retailers, and possibly consumer groups could prove to be very costly and time-

consuming, and lobbying efforts to win exemptions would be intense. All of these costs ultimately detract from the potential welfare gains of even a successful attempt to improve health through taxation.

The economic evidence on food price interventions to improve health outcomes is far from complete. More of this work is underway, and economists will also play an important role of assessing the success of any policies that are actually implemented. However, other approaches to improving diets also raise inherently economic questions, as they are all attempts to modify the behaviour of individual consumers. As Philipson et al. (2004) note, “Individuals make [food] choices in the context of limited time and income available in the presence of competing goods and activities with the objective of attaining multiple outcomes or goals, only one of which is health. The discipline of economics studies people’s choices under precisely these circumstances.” The widespread debate over fat taxes has increased awareness of this relevance both within and beyond our profession. Few people today question the role that diet plays in the burden of non-communicable disease, and there is considerable opportunity in this realm for economists to make a positive contribution to health and well-being.

The Relationship between Fast Food Incidence and the Prevalence of Obesity

The material in this section is currently being prepared for submission to an academic public health journal by Sean B. Cash, Ellen W. Goddard, and Ryan Lacanilao.

The increased incidence of obesity and overweight, particularly in wealthier countries, has been identified as a major public health concern. Access to "fast food" products has been suggested as a possible culprit. Understanding whether or not such claims have theoretical and empirical support is an important step in informing current policy debates over the use of policy interventions in addressing these dietary concerns.

The first objective of this study is to construct an economic framework to investigate both the differential presence of fast food restaurants across regions, and the varying incidence of obesity and overweight. The second objective is to apply this framework to recent data to characterize the relationship between fast food restaurant density and overweight and obesity across Canadian cities.

Obesity is a growing public health concern. Lake and Townshend (2006) point out that "in order to develop effective environmental interventions, in relation to obesity, we need to understand how individuals, and different groups of individuals, interact with their environments in terms of physical activity and food intake."

Empirical studies conducted using data on the United States show that fast food outlet density of an area has a positive relationship with percent obese (Maddock, 2004; Chou, Grossman and Saffer, 2004). One study looked at all-cause mortality rather than percent obese and found similar results (Alter and Eny, 2005). Other researchers investigated the relationship between socioeconomic status and fast food outlet density, generally finding that areas of low economic status tend to have higher fast food outlet densities (Block, Scribner and DeSalvo, 2004; Cummins, McKay and MacIntyre, 2005; Reidpath et al, 2002; Regan et al., 2006). Obesity is also a growing problem in children. Studies that focus on children found that fast food restaurants may cluster around schools but that fast food outlet density or food-store density is not associated with the body mass index (BMI) of school-aged children (Burdette and Whitaker, 2004; Austin et al., 2004; Sturm and Datar, 2005).

Methods

Conceptual Model

We begin by developing and presenting a theoretical model of how the accessibility of fast food may be related to the incidence of overweight and obesity, and also of what might determine differential access to fast food restaurants in different regions.

The prevalence of obesity in a certain area may be positively correlated to the number of fast food restaurants and average commuting time. This is because if there are more fast food restaurants in an area, people have greater access to them. The hypothesis is that with greater access, more fast food will be consumed by people in that area and since fast food is often high calorie food, places with greater access may have higher obesity rates. Also, if a group of people have a high average commuting time they may be more likely to eat at a fast food restaurant for time convenience. Obesity rates may be negatively correlated with median income since it costs more to eat healthy (CTV.ca News Staff, 2005). Also, accessibility to walking paths and health clubs may be negatively correlated to obesity prevalence since physical activity promotes a healthy body weight. The number of specialty coffee shops in an area might be associated with less obesity because the number of specialty coffee shops may serve as a proxy for the educated, higher economic status people to whom they cater.

Fast food restaurants might locate where there is more demand. Since fast food is a relatively cheap source of high calorie food, it might be demanded more in lower income areas. Since they locate in lower income areas, those with lower incomes have greater access to the fast food. It is uncertain whether the increased incidence of obesity can be attributed to the increased fast food access or whether the fast food restaurants are demanded more where the obesity rates are higher so that is where they choose to locate. According to Frank, Andresen, and Schmid (2004) travel time and built environment may also play a role in obesity. Greater commuting times may be associated with obesity because it is a form of physical inactivity, but as mentioned above, those who have longer commute times may tend to eat more fast food for the sake of time convenience.

We then apply this framework to an empirical example of overweight and obesity in Canada.

Empirical Example

Recent evidence from the 2004 Canadian Community Health Survey indicates that there are considerable regional differences in obesity rates across Canada (Shields and Tjepkema, 2006). For example, although the average rate of adult obesity in Canada is 23%, the estimated incidence in various cities ranges from 11.7% in Vancouver to 36.4% in St. John's (Shields and Tjepkema, 2006).

We use data on the location of fast food establishments from the 2005 Business Locations database (compiled by Environics Analytics, 2005) to construct various indices representing the accessibility of fast food across Canadian metropolitan areas (CMA), and investigate whether these indices can help explain the variation in obesity and overweight rates in these areas. We counted how many of each fast food restaurant included in Foodservice and Hospitality's (2005) "The Top 100 Listings," were in the Business Locations database. We then chose the ten with the most establishments in Canada to include in our analysis: Tim Hortons, Subway, McDonald's, KFC, A & W, Dairy Queen, Harvey's, Wendy's, Burger King, and Domino's Pizza. These are considered the "top ten" fast food restaurants. The top specialty coffee shops were included separately in the analysis. Starbucks, Second Cup, and Timothy's were considered specialty coffee shops. Each top fast food restaurant and coffee shop in Canada was coded.

Specifications about which communities belong to each CMA were obtained from Statistics Canada (Statistics Canada, 2001). Each community belonging to a CMA was coded accordingly. Since each CMA as well as each top restaurant was coded, we were able to count the number of restaurants in each CMA.

We obtained data on 2004 population, 2005 commuting time, and 2004 median income by CMA from Statistics Canada (Statistics Canada, 2007a; Turcotte, 2005; Statistics Canada, 2007b). All the data was entered into SPSS 14 for analysis through correlations and regressions. Some of the data used for analysis is displayed in Table 2.

Table 2: Partial listing of the data used in the analysis

CMA	Percent obese*	Fast food outlet density [†]	Coffee shop density [†]	Median income [‡]	Commuting time [§]	Population
St. John's	36.4	3.54	.17	57.10	47	180.7
Halifax	18.4	3.85	.26	61.40	65	379.2
Saint John	34.7	4.11	.00	55.20		126.6
Saguenay	18.9	1.69	.00	56.40		153.7
Quebec	17.3	1.97	.10	61.80	57	711.4
Montreal	21.2	1.44	.12	56.10	76	3609.6
Ottawa	19.7	2.54	.38	70.85	66	1141.4
Kingston	28.9	3.53	.13	63.70		156.0
Oshawa	29.6	1.78	.06	75.00	111	332.2
Toronto	15.6	2.05	.51	60.10	80	5214.0
Hamilton	34.6	3.00	.17	67.10	65	710.4
St. Catherines/N	23.1	3.31	.08	58.90	50	395.9
Kitchener	30.7	3.36	.18	69.20	61	451.8
London	26.6	3.38	.15	63.60	55	461.2
Windsor	33.2	3.30	.06	68.40	58	330.7
Greater Sudbury	26.1	3.91	.06	62.30	40	161.1
Thunder Bay	32.6	2.68	.08	64.60		126.7
Winnipeg	25.2	2.75	.24	59.40	61	702.4
Regina	31.8	3.08	.20	66.00	48	198.2
Saskatoon	27.0	2.94	.09	59.90	47	234.3
Calgary	25.7	3.23	.73	71.10	67	1038.7
Edmonton	20.1	3.14	.48	68.10	63	1002.7
Abbotsford	25.0	2.96	.25	53.70		158.8
Vancouver	11.7	2.03	.53	56.20	67	2174.0
Victoria	19.0	2.55	.45	64.20	59	329.8

* Obese is defined as BMI \geq 30.0

[†] Outlets per ten thousand population

[‡] Thousands of dollars

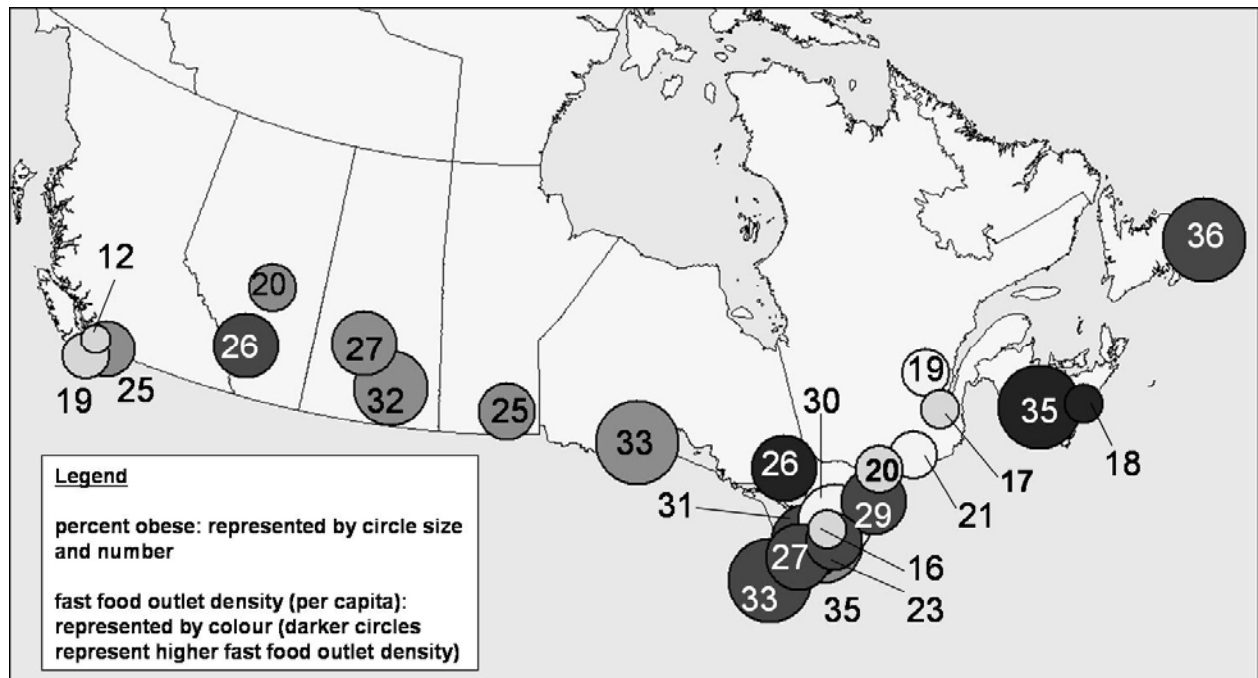
[§] Average duration of round trip between home and work (minutes) for workers living 1 km or more from workplace.

^{||} Thousands

Results

Figure 2 is a visual representation of the relationship between fast food outlet density and obesity. Each circle represents a CMA. The bigger the circle, the higher the obesity rate. The darker the circle, the higher the fast food outlet density (per capita). Except for a few outliers, the general trend is that the smaller circles are lighter and the bigger circles are darker. This shows a positive relationship between the obesity rate of a CMA and its fast food outlet density.

Figure 2: Visual representation of the relationship between fast food outlet density and percent obese across CMAs.



The accessibility and composition of fast food varies greatly across Canadian metropolitan areas, when investigated on either a per population or per unit area basis. Table 3 shows how these measures, when compared to obesity rates across cities, yield insights into how fast food access may impact dietary health. For example, population density measures of fast food accessibility are significant correlates of obesity rates, whereas area density measures or not. Furthermore, the “top 10” fast food population density measure is significantly correlated with the incidence of obesity (Pearson’s $r = 0.51$) and overweight and obesity combined ($r = 0.44$). Commuting time and median income were not significantly correlated with any obesity measures.

Table 3: Pearson correlation matrix for obesity and overweight prevalence measures

	Fast food top 10 per capita	Fast food top 10 per area	Coffee shops per capita	Coffee shops per area	Median income	% visible minority	Commuting time
% obese	.517 [‡] (.008)	-.008 (.969)	-.492 [†] (.012)	-.539 [‡] (.005)	.226 (.277)	-.523 [†] (.010)	-.188 (.427)
% obese and overweight	.437 [†] (.029)	.040 (.849)	-.362 (.075)	-.361 (.077)	.144 (.492)	-.446 [†] (.033)	-.255 (.278)
% child obese and overweight	.312 (.129)	-.147 (.483)	-.366 (.101)	-.154 (.463)	-.197 (.346)	-.112 (.611)	.092 (.699)

* Significance (2-tailed) in parenthesis.

† Correlation is significant at the 0.05 level (2-tailed).

‡ Correlation is significant at the 0.01 level (2-tailed).

The number of coffee shops per capita and per area were significantly negatively correlated with obesity ($r = -.49$ and $r = -.54$ respectively).

Table 4 shows the results from a multilinear regression. This model fits the data well ($R^2 = .708$). After controlling for median income and specialty coffee shop density, fast food restaurant density is still significantly correlated with fast food outlet density ($p = 0.019$). Surprisingly, the coefficient on income is positive and significant.

Table 4: Multilinear regression results.* Dependent variable: percent obese.

Variable	Coefficient	Std. Error	Sig.
<i>fast food top 10 per capita</i> [§]	3.273 [†]	1.285	.019
<i>coffee shops per capita</i> [§]	-19.158 [‡]	3.628	.000
<i>median income</i>	.404 [†]	.170	.027
<i>constant</i>	-5.586	8.95	.539
R^2	.708		

* Weighted Least Squares Regression – Weighted by population

† Coefficient is significant at the 0.05 level.

‡ Coefficient is significant at the 0.01 level.

§ Outlets per ten thousand population.

|| Thousands

A squared term for income was added to this model to explore the possibility of a nonlinear relationship between income and obesity. However, neither the income term nor the squared income term came out significant in this case. Some people hypothesize an inverted U-shaped effect of income on weight with individuals and across countries (Philipson and Posner, 2003; Lakdawalla and Philipson, 2002; Cash, 2007). However, this analysis shows that this is not the case across CMAs.

A variety of climate variables (average temperature, normal precipitation, normal rainfall, normal snowfall) were investigated but were not significant individually or jointly (Environment Canada, 2007). Furthermore, some were correlated with income and raised collinearity concerns.

Discussion

The data supports the hypotheses that incidence of obesity and overweight is positively related to the number of fast food restaurants and negatively related to the number of specialty coffee shops. A surprising result is that the data do not support the hypothesis that average commuting time is related to obesity prevalence. Another surprising result is that the multilinear regression suggests a positive correlation between the median income of a CMA and its percent obese.

A difficulty in this study is that because of the nature of the data, there are only 25 observations. There is nothing much that can be done to correct this since there are only a limited number of CMAs in Canada and if we start including other communities, they may be too small to justify being in the sample. Also, there may be some confounding factors that are not being taken into account. For example, number of bike trails in a CMA might be negatively correlated with its obesity rate, but this is not included in the analysis, and it would be difficult to obtain data on this. Another difficulty is that obesity rates are based on BMI, and this may not be the best measure for excess body fat. For example, a muscular athlete may have a very low percent body fat, but his or her BMI might report him or her as obese. If there is a CMA with an unusual amount of muscular athletes, this would bias the results.

Possible extensions of this study would be to include the number of health clubs or health food stores per capita in the analysis. Also, instead of using obesity rates, the morbidity due to cardiovascular disease could be studied.

Both theoretical and empirical evidence suggests that the incidence of obesity and overweight in a CMA is related to the accessibility and composition of fast food in that area, but the causal directions in this relationship are ambiguous. As the theoretical discussion illustrates, the placement of fast food businesses is an endogenous process that may be influenced by factors that are unobserved in our empirical study.

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Take Home Messages

- a) The use of “fat taxes” to address obesity at the population level may have regressive distributional effects. Furthermore, the use of such taxes will be difficult to implement in ways that will actually achieve noticeable reductions in obesity rates.
- b) The use of “thin subsidies” to lower the price of desirable foods may be easier to handle administratively, but would require expensive public outlays.
- c) The differing incidence of overweight and obesity across Canadian cities is strongly correlated with the density of fast food establishments in these cities.